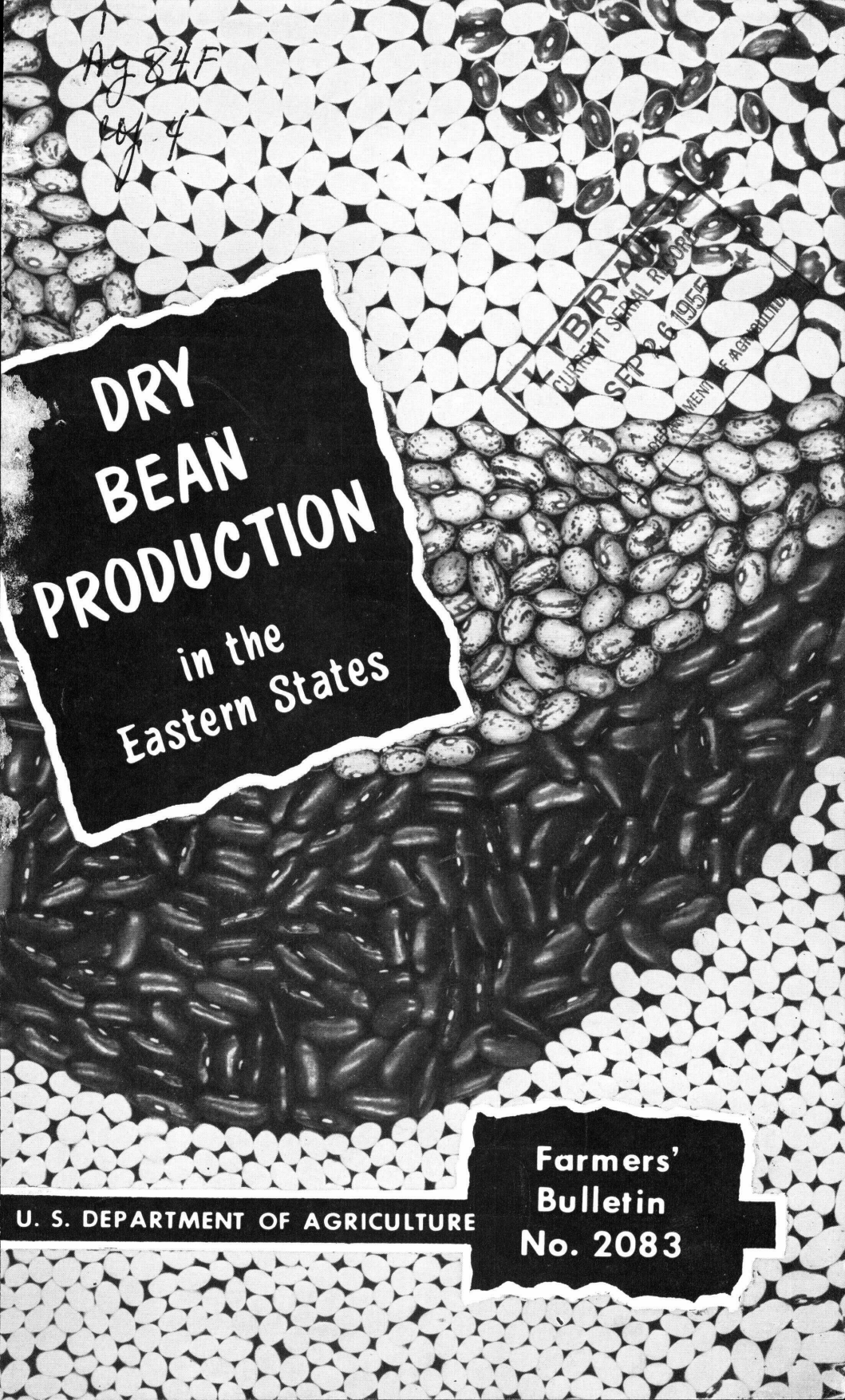

DRY BEAN PRODUCTION in the Eastern States

U. S. DEPARTMENT OF AGRICULTURE

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CONTENTS

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DRY BEAN PRODUCTION

in the Eastern States

By AXEL L. ANDERSEN, *senior pathologist, Horticultural Crops Research Branch, Agricultural Research Service*

Dry beans are an important item in the diet of the American people. They are relatively inexpensive and highly nutritious, being high in protein, phosphorus, iron, and vitamin B_1. The annual production in the United States is between 15 and 20 million 100-pound bags, and the annual consumption was approximately 9½ pounds for every man, woman, and child in the United States in 1952.

Approximately one-third of the dry beans in the United States is produced in central Michigan, western New York, and in the southwestern section of Maine (figs. 1, 2, and 3).[1] The remaining two-thirds is produced in the Western States, with California leading all States in total production.

LIMITING FACTORS IN BEAN PRODUCTION

Bean prices, like prices of other agricultural commodities, vary from season to season. Those dry bean types that are under Government price supports tend to fluctuate less in price, except during periods of low supply.

The first factor for the prospective grower to consider is the availability of bean handling and marketing facilities in the locality. If there is a bean elevator in the vicinity, the next consideration is the type of bean to grow. This will be determined by market preference and the ability of the dealer to handle the beans. Many elevators are equipped to handle only one or two types of beans.

All bean classes are not in direct competition with each other. Pinto beans, for instance, are preferred by people of Mexican descent; Yellow Eye beans are preferred by certain classes of people in New England and South Atlantic States; Cranberry beans are preferred in the Southeast; and Red Kidney beans are used mainly for canning.

High quality is assuming greater importance than ever before as competition has increased among various classes of beans. Great Northern and Pea beans compete in the dry packaging trade throughout the country, but the canning trade prefers the Pea bean because of its canning qualities. Cranberry and Pinto beans are entering into greater competition every year. Since quality is becoming a major factor and since disease and weather conditions influence quality, the susceptibility of varieties to disease and the climate must be considered in producing dry beans in the Eastern States.

The precipitation and the occurrence of hot, dry winds during the flowering season determine the southern limits of production in the Eastern States. Length of the frost-free growing season determines the northern limits. As dry beans are a comparatively short season crop, they are especially adapted to areas in which there is a frost-free growing season of 105 to 120 days.

[1] Small quantities of beans are produced in some other counties, but certain parts of some of the shaded counties do not produce beans.

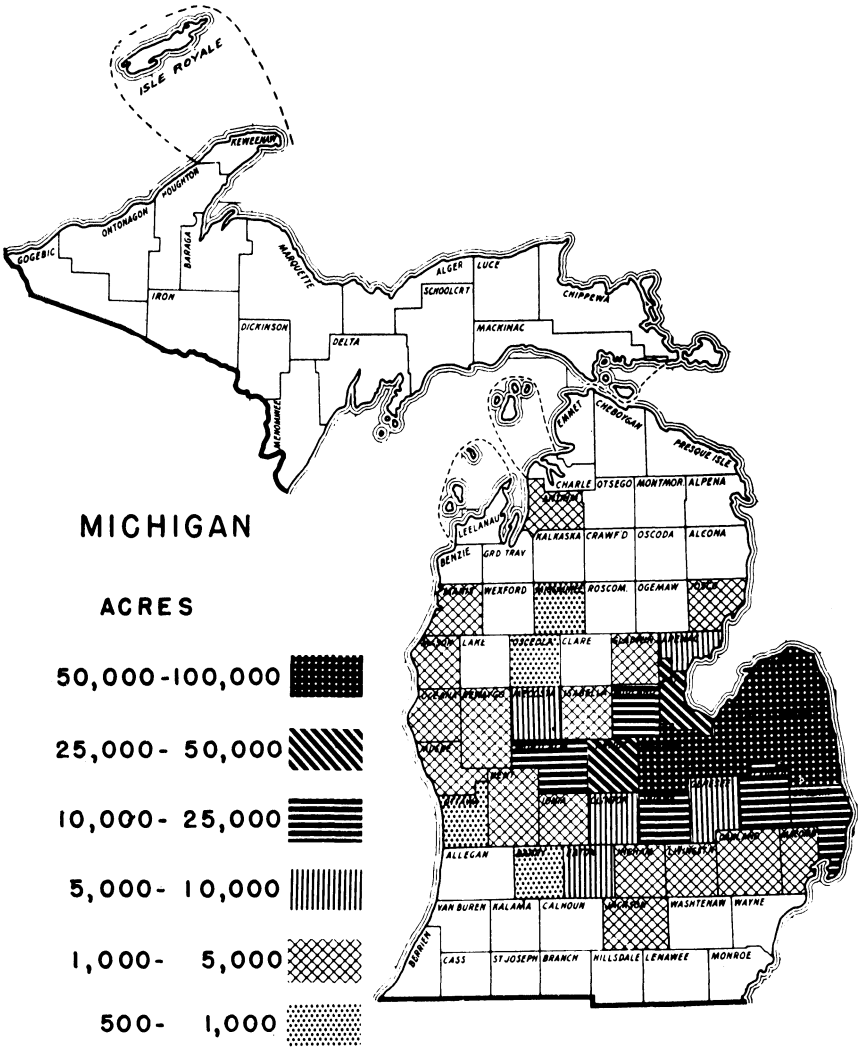

Figure 1.—Acreage of dry beans by counties for the State of Michigan. Data obtained from the 1950 U. S. Census of Agriculture.

Extensive drought periods during the growing season, and especially during pod-setting time, can lower the yields considerably. Similarly, cool, wet seasons are highly unfavorable, because beans are easily injured by excessive moisture and are subject to attack by diseases that thrive under these conditions. Hot, dry winds during blossoming may cause severe blossom drop and hence lower the yield considerably or may result in nonuniform ripening of the crop. Those plants that lose many of their first blossoms generally set more blossoms a week or 10 days later. Beans are killed by freezing, but even so are adapted to a fairly wide temperature range. Monthly means of 65° to 75° F. are the most favorable for bean growing.

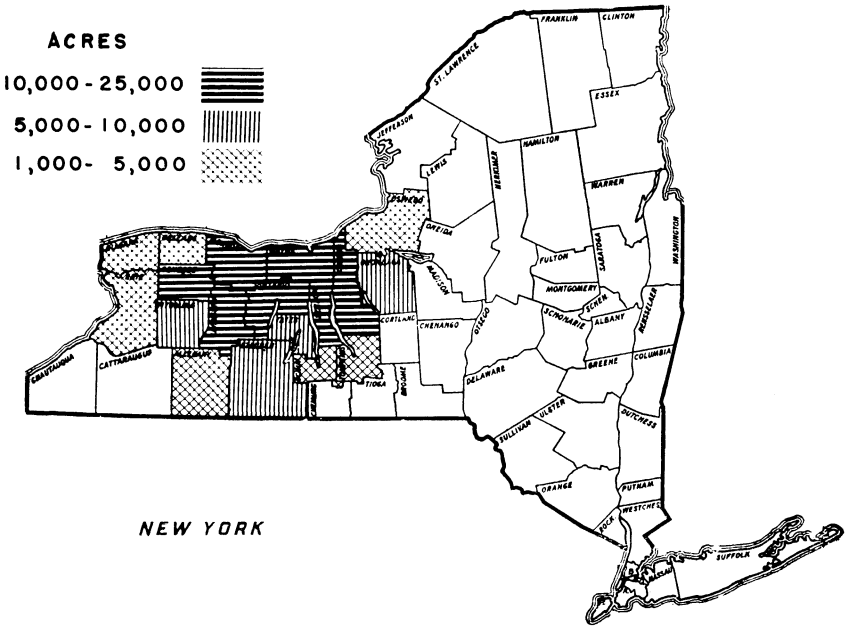

Figure 2.—Acreage of dry beans by counties for the State of New York. Data obtained from the 1950 U. S. Census of Agriculture.

Soil types, drainage, crop sequence, bean varieties and their susceptibility to disease, and the availability of equipment for growing and harvesting the crop are other factors to be considered.

Anyone interested in the production of dry beans should consult his county agricultural agent. Additional information may be obtained from extension specialists and State agricultural experiment stations, as well as industry representatives. The dates of planting, rates of seeding, fertilizers, rotations, and recommended varieties will vary considerably in each locality.

IMPORTANCE OF GOOD SEED

Probably the most critical item in the production of dry beans in the Eastern States is the quality of the seed. A number of the important diseases of beans can be carried in or on the seed, and these diseases are responsible for many of the low yields and much of the poor quality in beans sold. Also frost damage and wet weather damage at harvesttime prevent good germination of seed. In sorting Pea beans, the electric eye can remove discolored beans, but it is impossible to remove all of them, especially when the blemish is only on one side. The only way that discolored beans can be removed in colored bean types is by hand picking. With the present limited supply of labor and the prevailing high labor costs, this becomes an expensive operation.

SEED SOURCES

The dry bean seed used in the Eastern States comes mainly from the arid regions of the West and the humid bean areas of the East.

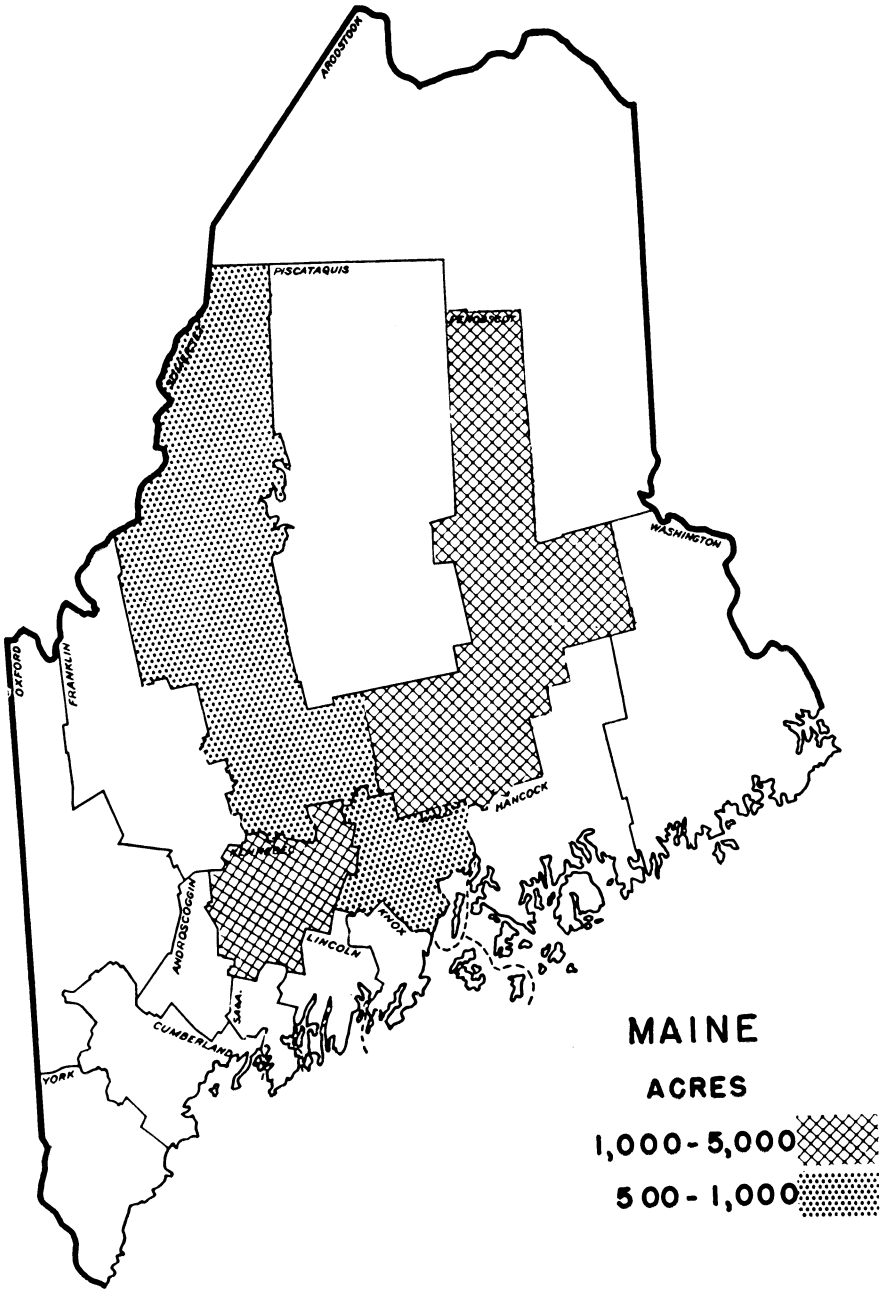

Figure 3.—Acreage of dry beans by counties for the State of Maine. Data obtained from the 1950 U. S. Census of Agriculture.

At the present time certified seed of Dark Red Kidney, Light Red Kidney, White Kidney, and Cranberry beans is available from the West. All certified seed, whether it is grown in the East or in the West, has passed inspection for disease freedom, quality, germination, and varietal purity by the seed-certifying agency in the State in which it was produced. Specifications for certification vary according to the State, but in all instances the standards are high, insuring good quality seed.

Many bean growers make the mistake of buying or using noncertified seed because it is cheaper than certified seed. Although the noncertified seed may look clean, the beans may be carrying bacterial blight internally. The beans may also be carrying some anthracnose infection. It would be next to impossible to detect 20 to 30 beans infected with anthracnose in a 100-pound bag of beans. If the infected beans were distributed uniformly throughout the field at planting time, they would serve as a source of infection of the other beans in the field. This could result in heavy loss in the crop should wet, humid weather occur during the growing season. A few extra dollars for the purchase of certified seed is one of the best investments a bean grower can make to assure himself a bean crop of high quality and better than average yield.

Noncertified seed is also available from the West; but unless the seed is from a variety or type commonly grown in and adapted to the East, the grower should buy certified seed.

Western-grown seed has a distinct advantage over eastern-grown seed insofar as disease freedom is concerned. The seed grown in California and Idaho is produced under surface irrigation in an arid climate. Bacterial blights and anthracnose disease organisms cannot survive well under these conditions. As a result the seed from the West will produce beans relatively free from these diseases in the Eastern States unless other sources of inoculum are involved. The common bean mosaic virus, which is also carried through the seed and which does not depend upon humid weather for spreading, can still be borne in the seed. However, if certified seed is used, probably little or no common mosaic will be present in the seed.

BEAN TYPES AND VARIETIES

Dry beans vary in shape, size, and color, including various mottlings. The more important types grown in the Eastern States are illustrated in figure 4. The Pea, Red Kidney, and Yellow Eye are grown in Michigan and New York. The Cranberry is produced principally in Michigan, whereas Marrow and White Kidney beans are grown in New York. Yellow Eye is the most important bean grown in Maine, with small acreages of Red Kidney in certain localities.

Cranberry

Michigan Cranberry is an old variety of the Horticultural type. The variety is grown largely in Michigan.

Marrow

Perry Marrow is a large white bean developed by the agricultural experiment station of Cornell University and released to seed com-

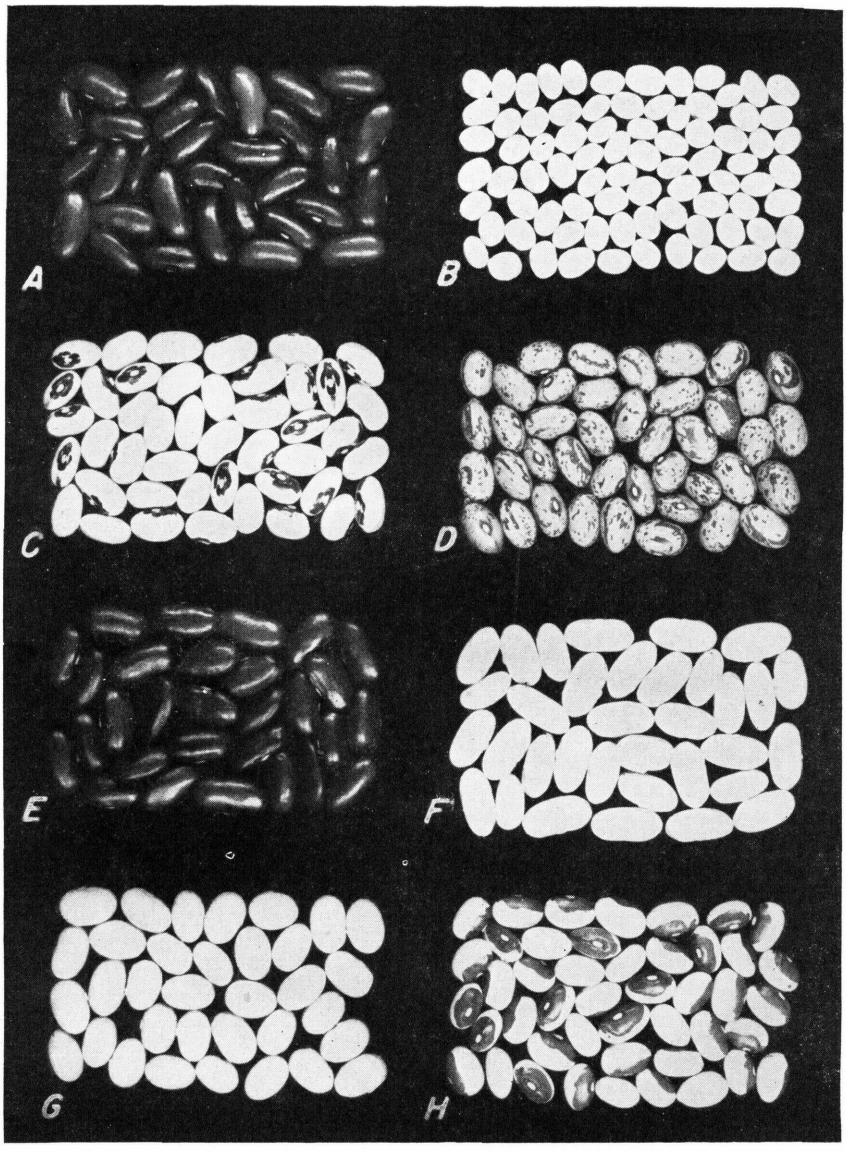

Figure 4.—The principal dry bean types grown in eastern United States: *A,* Light Red Kidney; *B,* Pea; *C,* Yellow Eye (New England, or soldier-eye, type); *D,* Cranberry; *E,* Dark Red Kidney; *F,* White Kidney; *G,* Marrow; and *H,* Yellow Eye (New York, or Michigan, type).

panies in 1921 for propagation. It was derived from a cross between Wells Red Kidney and the White Marrow beans. In 1942 the seed on the market was found to be a mixture of Perry Marrow, Pea, and other white beans. Reselections were made by the Cornell station and planted in the field in rows. The strain of Perry Marrow presently grown for certification resulted from an increase of one of these rows.

Pea, or Navy

Michelite is a high-yielding midseason bean with a glossy white coat. It is resistant to common bean mosaic virus 1 and highly tolerant to bacterial blight. The variety was developed by the Michigan Agricultural Experiment Station and introduced in 1937. This variety, which was derived from a cross between Robust and Early Prolific, has now replaced nearly all the old varieties of Pea beans in Michigan and New York.

Monroe is a variety slightly larger than Michelite. It is resistant both to common bean mosaic virus 1 and to the variant strain, to which Michelite is susceptible. Monroe was developed by the Cornell Agricultural Experiment Station and introduced in New York to replace Michelite. It was derived from a cross between U. I. Great Northern 1 and Michelite, backcrossed 3 times to Michelite.

Robust, Rainey River, Bluepod, Early Ryan, and *Snowflake* are some of the older varieties produced in limited quantities. All these varieties are less tolerant to diseases that attack Pea beans than either Michelite or Monroe.

Red Kidney

Dark Red Kidney is an old variety commonly grown in Michigan. It is very susceptible to bacterial blight and anthracnose; hence, it is recommended that western-grown seed be planted.

Light Red Kidney, California strain (Red Kidney 7811), was introduced in 1937 by the California Agricultural Experiment Station. It was developed from a cross between Nagazura and Red Kidney backcrossed to Red Kidney.

White Kidney

White Kidney, California strain, is a selection made from the old White Kidney variety. It was released by the California Agricultural Experiment Station in 1943.

Yellow Eye

Yellow Eye, New York, or Michigan, type, is a large, white, round to oblong bean. It is an old variety with a large, yellow, oval spot on the hilum ("eye" of bean). This variety is grown for certification in New York.

Yellow Eye, New England, or soldier-eye, type, is similar to the New York, or Michigan, type, except that the yellow spot has the pattern of a soldier.

Other Types

Black Turtle Soup, or *Venezuelan,* is a black bean grown in limited quantities in New York.

Jacobs Cattle is a large red-and-white mottled bean produced in Maine.

Table 1 lists the principal varieties or types of beans grown in the Eastern States, the diseases to which they are resistant, and the States in which certified seed is grown.

TABLE 1.—*Principal commercial varieties and types of dry beans grown in the Eastern States, resistance or susceptibility to certain diseases, and the States in which they are certified*

Variety or type	Common seed-borne diseases [1]							States certifying
	Bean anthracnose strains			Bacterial blights		Mosaic [2]		
	Alpha	Beta	Gamma	Common and useous	Halo	Common	Variant strain	
Michelite (Pea, or Navy)	S	R	R	S	R	R	S	Michigan and New York.
Monroe (Pea, or Navy)	S	R	R	S	R	R	R	New York.
California Light Red Kidney.	R	S	S	S	S	S	S	California.
Dark Red Kidney	R	S	S	S	S	S	S	Do.
California White Kidney	R	S	S	S	S	S	S	Do.
Perry Marrow	R	R	S	S	R	S	S	New York.
Cranberry	R	S	S	S	S	S	S	California.
Yellow Eye (New York, or Michigan, type).	R	S	S	S	R	S	S	New York.
Yellow Eye (New England, or soldier-eye, type).	R	S	S	S	R	S	S	Not certified.

[1] S=Susceptible to disease; R=resistant to disease.

[2] Two strains of common bean mosaic attack beans. The variant, or Burkholder's strain, attacks varieties that are resistant to the common strain of mosaic.

SOIL TYPES

Dry beans are suited to many soil types. Beans grow best in well-drained sandy loam, silt loam, or clay loam soils high in organic content. They are very sensitive to excessive soil moisture; under this condition disease troubles are usually encountered. Standing water will injure the plants in a few hours. In many areas where drainage is poor, tile drainage is essential to the production of good yields. Sandy soils are not well suited for bean production; but by building up the organic content, soils of this class produce good yields of beans.

CROP ROTATION

Some system of crop rotation or crop diversification is usually necessary to maintain high yields and quality of beans. A rotation with at least a 3- or 4-year interval between bean plantings on any one field is a good practice. To hold root rots under control, beans should appear only once in a 6-year rotation. Successive cropping of beans is hazardous, because of the danger of losses from diseases carried in the soil and on plant refuse. For the same reason it is risky to spread bean straw or manure from bean straw onto land immediately preceding a crop of beans.

Although the bean is a legume, such legumes as alfalfa, sweetclover, red clover, and alsike clover are grown in the bean rotation to supply

nitrogen and replenish the organic-matter content of the soil. As dry beans are normally grown and harvested, they deplete rather than replenish the soil nitrogen, although they do not take as much out of the soil as do many other row crops. A standard recommendation for rotations in the Eastern States is one or two row crops followed by small grains seeded to a hay, pasture, or a green-manure crop.

In any rotation dry beans should follow the leguminous green-manure crop that has been plowed under in the spring. For maximum yields the green-manure crop should be turned under prior to May 15. Sweetclover should be plowed under when it is 8 to 14 inches high. During seasons of subnormal spring rainfall, delaying the plowing under of the green-manure crop may damage the bean crop, as the green-manure crops may use most of the available soil moisture.

LAND PREPARATION

The same farm machinery is used in soil preparation, planting, and cultivation for the growing of beans as it is for other row crops. Although the steps involved in preparing the land for seeding may vary according to the previous crop and the soil type, the establishment of a friable seedbed is the best means for conserving soil moisture.

If a green-manure crop is not to be turned under, the type of soil and the terrain determine to a great extent the time to plow. Fall plowing usually provides a more friable seedbed in heavy soil. If there is danger of soil erosion from winds and water runoff during the winter months, then it is better to wait until spring to plow. Occasionally a field cultivator or a chisel-type cultivator plow is substituted for the conventional plow.

After plowing, the disk, harrow, and cultipacker pulverize and level the seedbed. Repeated harrowing prior to planting destroys many weeds and makes subsequent weed control easier.

FERTILIZATION

Application of moderate amounts of fertilizers increases bean yields, although the return per dollar spent for fertilizers may be smaller than with some other crops. Care must be taken in applying fertilizer, as bean seed is very subject to injury when it comes in direct contact with the fertilizer.

One method of increasing bean yields is to fertilize other crops liberally in the rotation. For example, at the time alfalfa or sweetclover is sown, 200 to 400 pounds per acre of 0–20–10 or 0–20–20 may be applied. When the alfalfa or sweetclover is turned under, sufficient nitrogen, phosphoric acid, and potash are usually in the soil to produce a good crop of beans. However, an application of fertilizer at planting time may still be needed for maximum yields of beans. If no green-manure crop is turned under, band applications of fertilizer will increase the yield of beans sufficiently to warrant the application of the fertilizer.

The Michigan Agricultural Experiment Station recommends application of 200 to 400 pounds of 3–18–9 or 4–16–8 fertilizer placed in bands 1½ to 2 inches below and about 1 inch to one side of the seed. Using this method of application, bean yields are usually increased 4 to 5 bushels per acre. If the broadcast method of application is used,

more than 1,000 pounds of fertilizer per acre is required to obtain similar increases in yields.

The New York station recommends 400 pounds of 8–16–8 on sandy soils or 300 pounds of 8–16–8 per acre on loamy soils, banded with the planter or drill, if the beans follow a sod or green-manure crop. If beans follow a cultivated crop, the station recommends 700 pounds per acre for sandy soils and 650 pounds for loamy soils. When this fertilizer rate is followed, the first 400 pounds is drilled in immediately after plowing and the rest is applied in bands with the planter.

At the present time (1954), the Maine Agricultural Experiment Station recommends the broadcast application of 600 to 700 pounds of 4–12–8 fertilizer per acre prior to seeding. Recent studies indicate 1,000 pounds of 5–10–10 fertilizer per acre would provide better returns.

Manganese deficiency is occasionally noticeable, especially for lake bed soils with a pH of 6.5 or higher. To overcome this deficiency, mix 100 to 200 pounds of manganese sulfate per ton with the fertilizer immediately prior to its use. If the fertilizer is to be stored for some time, move the sacks every 4 or 5 days to prevent hardening.

The details of use of fertilizers depend largely upon the system of cropping and the application of fertilizers in the cropping system. For information regarding the use of commercial fertilizers in any particular locality, consult your county agent, extension specialist, or the State agricultural experiment station.

INOCULATION

The artificial inoculation of bean seed with nitrogen-fixing bacteria is considered of no advantage. Tests in Michigan, New York, and elsewhere on both old and new bean soil have shown no benefits from seed inoculation.

PLANTING

A grain drill, a corn planter with bean-plate attachment, or a special beet and bean drill is generally used to plant beans, in rows 28 inches apart. Planting beans at the minimum depth that will obtain good coverage and sufficient moisture to promote fast germination and growth is best. If the beans are planted too deep, the soil may hinder the seedlings from breaking through the surface and will also expose them to possible damage from seed decay and damping-off, as well as injury from the seed-corn maggot. If the soil is cloddy at the time of planting, using a cultipacker before planting or immediately after planting will improve the seedbed.

The use of weather reports giving weekly forecasts should be very helpful to the bean grower in determining how and when to plant. The temperature for the period after planting should be warm (above 65° F.), so the beans can germinate quickly. If it is a dry season and there is little moisture in the surface soils and no immediate forecast of rain, plant the beans in contact with moisture even if this is 3 to 4 inches deep. The contact with moisture will assure quick germination. On the other hand, if there is a possibility of heavy rains and the soil is fine in texture, plant very shallow or shallow (1 to 1½ inches). If the forecast is for cold and wet weather, wait until more favorable weather is in sight.

Planting dates vary from locality to locality. However, beans should not be planted until the soil temperature is above 65° F., a

condition that will assure immediate germination and emergence of the beans. All conditions that favor rapid germination and emergence will minimize the damages from fungus and insect injury. Generally, field beans are planted from June 1 to 10 in the Eastern States. Beans planted the latter part of June are almost certain to be injured by fall frosts in those areas where the average frost date is September 20 to 30.

Planting rates vary, depending on the variety. In Michigan, with rows 28 inches apart, Pea beans yielded the best when planted at 40 pounds to the acre, Red Kidney beans at 80 pounds, and Cranberry and Yellow Eye beans at 60 pounds. These rates are heavier than those followed by many growers. However, if there is much danger of damage from damping-off or from seed-corn maggots or if the ground becomes crusted, the chances are better for a good stand at the heavier rates of seeding.

CULTIVATION

The main purpose of cultivation is weed control. Weeds are readily destroyed shortly after their emergence. At this stage, little root development has taken place. Weed control should begin during the preparation of the seedbed and continue after the beans are planted. Special weeders or a spike-tooth harrow may be used from the second or third day after planting until the plants are 4 to 5 inches tall. It is best not to use these implements at the time the plants are emerging from the ground and while the stems still have the crook in them. At this stage they are brittle and easily injured. Furthermore, use the weeders in the afternoons or when the plants are less turgid and brittle, and, therefore, are less easily broken.

If heavy rains pack the soil so the beans cannot emerge, loosen the soil surface with a spike-tooth harrow or weeder to prevent complete loss of the beans.

If the cultivator is the only implement to be used, the first cultivation should take place soon after the beans have emerged and are in the two-leaf stage. The use of cut-and-cover cultivator attachments next to the row and sweeps in the center of the row will remove weeds close to the row. At the same time the soil is rolled around the plants, covering and smothering the small weeds next to the plants that could not ordinarily be taken out by the cultivator. By using these attachments, deep cultivation is avoided and unnecessary root injury and moisture loss are prevented.

Cultivation should be as infrequent and as shallow as possible and still control the weeds (fig. 5). Cultivate with care late in the season, so as to avoid injuring the roots extending out between the rows just beneath the soil surface. Injury to the feeding roots at blossoming and at pod-setting time may cause wilting of the plant, blossom and pod drop, and an eventual reduction in yield.

Thorough cultivation will not always remove all the weeds in a field. Pull or hoe those weeds that cannot be removed by cultivating equipment. Weeds not only interfere with crop growth but also hinder harvesting and curing of the beans.

Never cultivate beans while wet from either dew or rain, as disease organisms are more easily carried from plant to plant by farm implements when the plants are wet.

Figure 5.—Cultivating Pea beans planted in rows 28 inches apart, using a 4-row cultivator.

Some preemergence sprays control weeds satisfactorily in bean fields. Generally, more effective control is obtained when the chemical sprays are applied after the majority of the bean seedlings are in the crook stage of development. Beans at this stage appear to have greater tolerance for weed killers than at either earlier or later stages of growth. Although 2,4–D can be used successfully, this compound may cause a 7- to 10-day delay in ripening of the beans. Dinitrophenol and penta-chlorophenol formulations give good weed control without injury or delay in maturity. Effects of chemicals on both beans and weeds are dependent upon soil type, moisture, temperature, and type or variety of beans. For this reason it is advisable to consult local agricultural agencies before attempting to use herbicides in a bean crop.

HARVESTING

Harvesting is one of the crucial stages in bean production. Delay harvest until most of the pods are dry and the beans have hardened, in order that the period between pulling and threshing or combining can be kept as short as possible. Although high temperature and humidity sometimes damage mature beans while standing in the field, such conditions generally cause greater and more frequent losses while the crop is curing in windrows or bunches. The more immature the crop is at the time of pulling the longer the plants with attached pods have to remain on the ground or in the stack to mature and the greater are the chances that the beans may become moldy and discolored.

Since 1948 development of farm equipment for harvesting beans makes it possible for 1 or 2 men to do the work that formerly required 3 or 4. It is not unusual now (1954) for 2 men with the proper equipment to harvest 20 to 30 acres of beans in 1 day. A 1-man tractor-drawn puller-windrower is now available that elevates the beans

immediately after they are pulled, shakes off the stones and soil, and delivers the pulled beans in a windrow in 1 operation (fig. 6). After curing, a 1-man self-propelled combine threshes the beans directly from the windrow and discharges them directly into a truck driven alongside (fig. 7).

Figure 6.—Pulling and windrowing beans with a harvester and an attached side-delivery rake.

Figure 7.—Threshing beans from the windrow with a self-propelled combine. Trucks can be loaded without stopping the combine, and the beans hauled to elevators.

Beans are usually pulled and windrowed during the morning hours while the plants are damp and the pods are tough, in order to minimize shattering of the beans. Pulling is immediately followed by windrowing before the plants have had a chance to dry out. Curing can be speeded up by turning the beans in the windrow daily, either by hand or with the windrower. In fair weather beans are cured in a day or two and are then ready for threshing.

The windrow method of curing works well if the weather is favorable. But if wet, humid weather sets in during harvesting, as it so often does in the Eastern States, additional steps are usually needed to cure the beans. Well-made stacks built around posts in the field allow the beans to complete their curing from newly windrowed plants.

The stacking procedure is as follows: Drive a 7-foot steel fence post or heavy stake firmly into the ground. Place a 1-foot layer of clean straw around the post so the diameter is approximately 3 feet. Build the bean stack around the post with straight sides to a height at least 2 feet above the top of the post. The sides may be 6 inches wider at the top than at the bottom.

Inexperienced workers can stack an acre of beans yielding 20 to 25 bushels per acre in approximately 3 man-hours. By stacking the crop, a maximum of high-quality beans can be procured even though the beans are harvested before they are uniformly ripe.

USE OF THE STRAW

Since 1945 most of the straw from dry edible beans is spread back over the field to decompose and to aid in maintaining fertility. Occasionally the straw is windrowed after combining and baled for use as feed or bedding. In some instances farmers attach a box trailer to their combine for catching the straw and hauling it immediately to the barn (fig. 8).

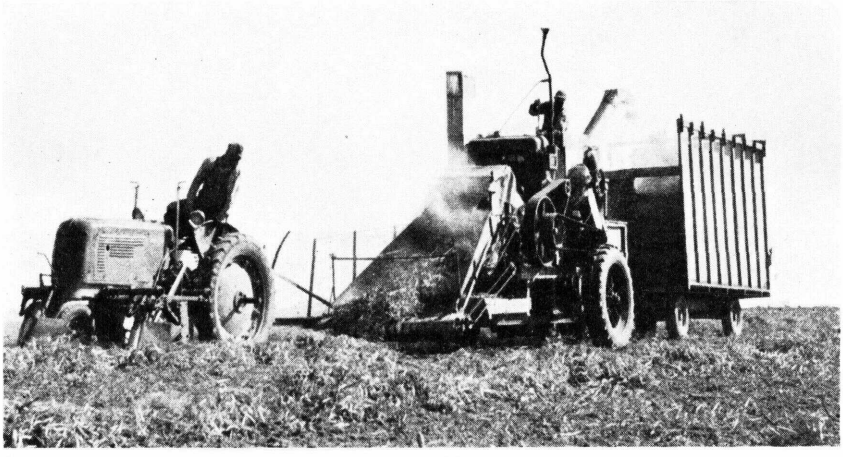

Figure 8.—Some farmers save their straw for bedding purposes, using a box trailer attached to the rear of the beaner to catch and haul it.

MARKETING, CLEANING, AND GRADING

The quality of the crop and the price at harvesttime determine for most farmers whether they market the beans promptly after threshing or store them on the farm. Many farmers, however, consistently follow one practice year after year regardless of price at harvesttime.

Limited space is available in most areas for commercial storage of beans for farmers. Most commercial space is used by elevator interests to store the beans they buy at harvesttime for processing and sale throughout the balance of the year.

Since the combine has come into general use for harvesting beans, most beans are delivered to county elevators in bulk by truck. The beans are then weighed, sampled to determine quality and price, and dumped into a pit for elevation into the elevator.

Pea beans are purchased from farmers on the basis of the price for Choice Handpicked grade. The sample from a farmer's load is

"picked" to sort the good beans from the splits, discolored beans, stones, straw, and other foreign material. The amount paid to the farmer for the load is determined by multiplying the original net weight of his delivery in pounds minus the weight of the "pick" by the price per pound for Choice Handpicked grade. From this price is subtracted a picking charge per pound, which varies from year to year, depending upon relative costs of operation.

Most country elevators process the beans by putting them over a cleaner, stoner, and jigger or gravity mill, the extent of their processing depending upon their facilities and the quality of the crop.

The condition of beans on hand largely determines the degree of processing and the method of disposal of the beans by the country elevator man. Following crops of good quality, he is often able to process the beans sufficiently to meet the standard for No. 1 grade for screened beans (pp. 15 and 16) and ship direct to merchants and large users in 100-pound bags. But when beans are of low quality and a high proportion must be picked out because of discoloration, the country elevator man may not be able economically to process his beans sufficiently to meet the higher grades. In this case he ships them in bulk carloads to major processing terminals at which electric-eye sorting machines pick the beans to a Choice Handpicked grade.

Beans are graded according to their quality by private, State, and Federal inspectors. The State bean shippers associations maintain their own inspection services for their members, but these are not official so far as the State and Federal departments are concerned. The State of New York adopted the United States Standards for inspection, whereas the State of Michigan uses two standards, one based on State regulations and the other on Federal regulations. The percentage of total defects permitted under United States Standards for beans are given below.

U. S. Grade	*Maximum limits of total defects (percent) consisting of splits, damaged beans, contrasting classes, and foreign material* [1]
Handpicked or specially processed beans: [2]	
U. S. Choice Handpicked	1. 5
U. S. No. 1 Handpicked	2. 0
U. S. No. 2 Handpicked	4. 0
U. S. No. 3 Handpicked	6. 0
Screened beans: [3]	
U. S. No. 1	2. 0
U. S. No. 2	4. 0
U. S. No. 3	6. 0
U. S. Substandard	Those beans that do not meet the requirements of the U. S. Nos. 1, 2, or 3 or for the U. S Sample grade.
U. S. Sample grade	Includes beans of any of these classes that are musty, sour, heating, materially weathered, weevily, or are otherwise of low quality.

[1] Data obtained from U. S. Dept. Agr Prod. and Mktg. Admin., Revised United States Standards for Beans (effective May 1, 1950).

[2] Except Blackeye, Cranberry, Pinto, and the various classes of lima beans.

[3] Cranberry and Pinto bean standards are 4.0, 6.0, and 8.0 percent for U. S. Nos. 1, 2, and 3, respectively.

Michigan State standards are used in the sale of all Michigan beans except those that are sold to State agencies outside Michigan, to Federal agencies, and for export. The percentage of total defects permitted under Michigan Standards for dry edible beans is given below.

Michigan Grade	*Maximum limits of total defects (percent) consisting of splits, damaged beans, contrasting classes, and foreign material* [1]
Handpicked beans: [2]	
Michigan Choice Handpicked	1. 5
Michigan Prime Handpicked	3. 0
Screened beans: [2]	
Michigan No. 1	2. 0
Michigan No. 2	3. 0
Michigan Picking Stock	Includes beans that do not meet the specifications for any of the established grades.

[1] Data obtained from Mich. Dept. Agr. Regulation No. 523, December 27, 1947.
[2] Cranberry and Yellow Eye beans may contain an additional 2 percent split, but otherwise sound, beans of the same class in any of the established grades; total maximum tolerance for defects in kidney beans shall be 2 percent in the Choice Handpicked and No. 1 grades and 4 percent in Prime Handpicked and No. 2 grades.

All beans, except those shipped as "picking stock" from one bean plant to another for further processing, must be inspected prior to shipment by a licensed bean inspector supervised by the State department of agriculture and must carry an inspection certificate citing the grade.

Three colored types—Red Kidney, Cranberry, and Yellow Eye—are handled in most respects like Pea beans with the exception that they are bought on the basis of No. 1 grade and for the most part are processed to No. 1 grade. Because of their color they are not adapted to the electric-eye picking machines. When necessary they are handpicked.

Cull beans usually find a market among livestock feeders or feed manufacturers. Split beans become a sales problem, especially in dry years when the handling and processing make a high percentage of splits. During the war years and immediately thereafter, splits were in demand for export as human food. Split beans are not accepted by consumers in this country, in contrast to split peas that are purposely split at an extra cost to meet consumer demand.

DISEASES [2]

Losses to bean growers from disease infestations occasionally amount to several million dollars annually. Many growers in the Eastern States have sustained complete loss from disease.

In general losses caused by bean diseases can be held to a minimum by applying the following cultural practices: (1) Plant disease-resistant varieties when available; (2) use disease-free seed (certified seed is recommended); (3) practice at least a 3- or 4-year crop rotation; (4) keep fields clean by plowing under bean refuse; (5) avoid working in beanfields while they are wet; (6) treat the seed with recommended chemicals to prevent damping-off and seed decay and seed-corn maggot injury. (See Precautions, p. 28.) Airborne diseases can be controlled by spraying the field with chemical fungicides.

Seed infection is not readily visible in colored beans; hence, carefully select planting seed of these types and obtain certified seed if available.

The important diseases of beans are described fully in Farmers' Bulletin 1692, Bean Diseases and Their Control. A copy of this bulletin can be obtained by writing to the Office of Information, United States Department of Agriculture, Washington 25, D. C.

[2] A list of the causal organisms is given on p. 29.

Anthracnose

Cause

Bean anthracnose is caused by a fungus that is seedborne and is capable of living in the soil for a period of 2 years. It is spread by rain, insects, farm implements, and man. The fungus thrives especially well in moderately cool, humid, and rainy weather. It attacks all aboveground parts of the plant and at almost any stage of the growth.

Symptoms

Bean seed infected with anthracnose will have dark and sometimes raised lesions that may extend beneath the seedcoat. If infected seed is planted, the new plant is generally infected and the disease becomes established in the field. The fungus produces dark-brown to reddish sunken cankers on stems and on veins of the leaves. Dead angular spots, reddish in color, appear on the surface of the leaves (fig. 9). Occasionally whole plants are killed.

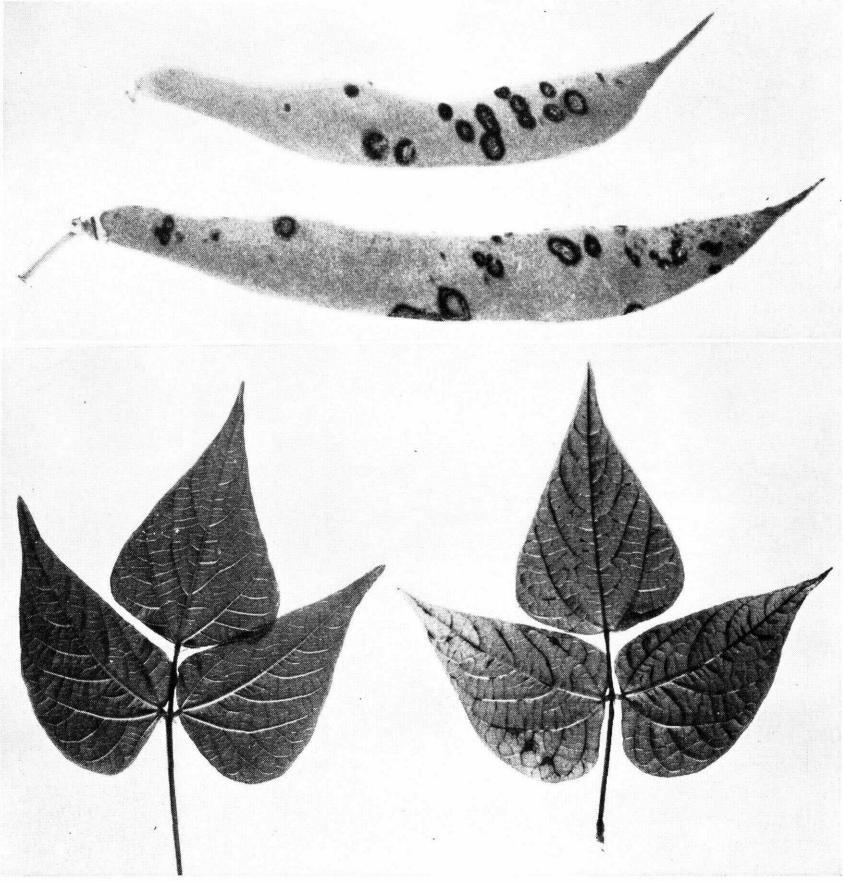

Figure 9.—Pods and leaves with anthracnose infection. The rusty-brown lesions on the pods are sunken, with masses of pink spores in the center of each lesion.

The deep rusty-brown lesions, or cankers, are more or less circular on the pod. In the center of each lesion are numerous spores, or "seeds," that are pinkish in color. Through deep pod infections the fungus establishes itself in the seed.

Control

To control anthracnose effectively, follow the general cultural practices listed above. Spraying also reduces anthracnose infection. Phygon XL, Fermate or Karbam-black, Dithane Z–78 or Parzate, and Zerlate, Zimate, or Karbam-white are reported to be effective fungicides. Follow manufacturer's instructions carefully when using these chemicals.

Bacterial Blights

Cause

Several distinct organisms are responsible for bacterial blights, but the symptoms and control are similar. Frequent rains, heavy dews, and humid weather of the eastern dry bean sections favor the spread and development of bacterial organisms. In general warm weather favors the development of common blight, fuscous blight, and wilt, and cool weather favors halo blight.

Bacteria commonly enter the bean plant through the stomata (breathing pores) of leaves, stems, and pods. The bacterial ooze from the diseased plant adheres to insects, clothing, farm implements, and animals and is spread by these carriers. The bacteria may remain alive for many years in the seed and may overwinter for 2 years in dead plant material in the soil.

Symptoms

Bean seed infected with common blight is generally discolored and may be small and shriveled. Yellow discolorations that can be seen through the seed coat show up on heavily infected white-seeded varieties. The bean seedling becomes infected at the point of attachment of the seed leaves, or cotyledons. Sometime before it matures, the plant topples over, breaking at the point of attachment. This symptom is known as node blight, or stem girdle. The infected part is reddish brown and may be completely decayed. Often it appears that the injury has resulted from the invasion of an insect. The lesions that appear on the stems, leaves, and pods as small water-soaked spots gradually increase in size and become reddish. Later, dead areas surrounded by yellowish-brown areas appear on the leaves (fig. 10). The leaves become riddled or shredded. The bacteria may attack the seed through the infected hinge of the pod. In early infections the seed is completely rotted, but in later infections the seed appears varnished. Common and fuscous blight organisms produce a yellow bacterial ooze.

The bacteria causing halo blight produce a white ooze, and the disease can be recognized by a light-green halo surrounding the point of infection.

Bacterial wilt infections appear as oblong lesions between the veins of the leaves. Pod infection often cannot be detected until the pod is opened. The infected seeds are yellow and shrunken.

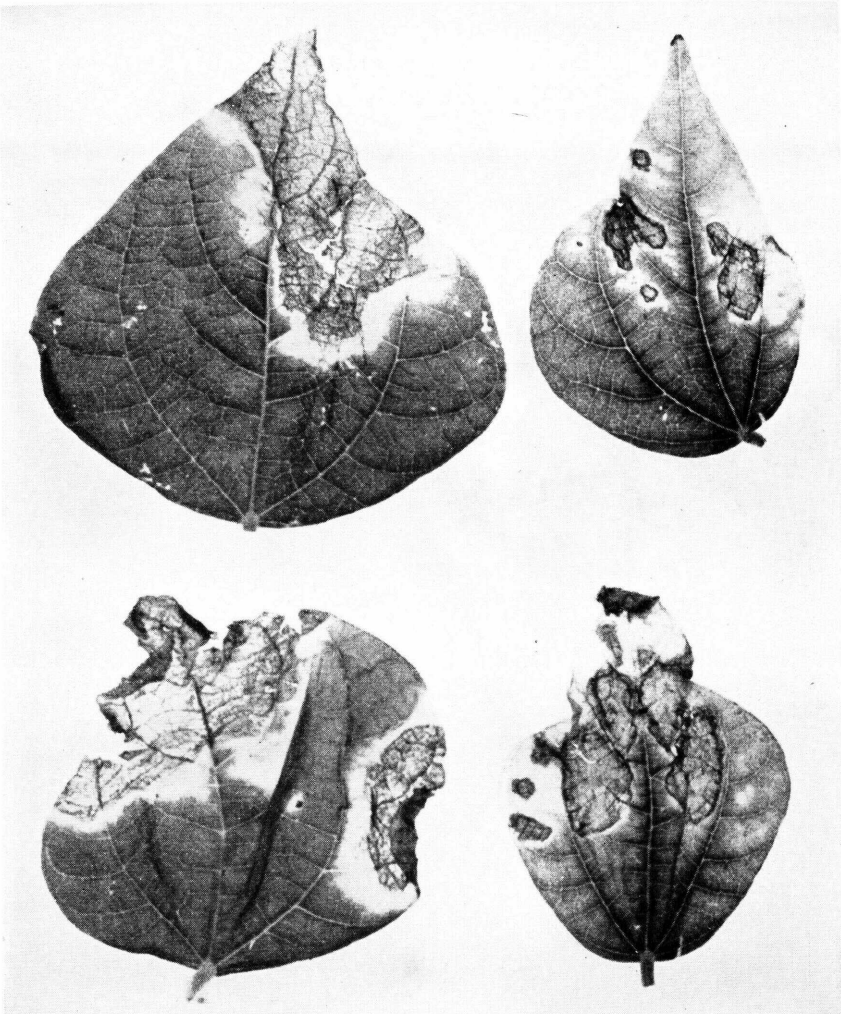

Figure 10.—Advanced stages of bacterial blight (common and fuscous types) on bean leaves.

Control

To control bacterial blights, follow the cultural practices listed on page 16. Bean seed produced in certain Rocky Mountain and Pacific States is comparatively free from the common blights, as the climate does not favor the growth and spread of these bacteria. All varieties of beans are more or less susceptible to the common blights, but the pea beans are resistant to halo blight.

Mosaic

Cause

Bean mosaics are caused by viruses that are carried most commonly by aphids (or plant lice). The aphids spread the viruses by feeding on infected and then on healthy plants.

Common bean mosaic is transmitted through the seed, much like anthracnose and bacterial blight. Infected seed cannot be distinguished from noninfected seed by visual inspection.

Yellow bean mosaic is not transmitted by seed. It overwinters in sweetclover, crimson clover, red clover, and gladiolus and is transmitted by insects. Once established in beans it can be carried to other beans by aphids.

Symptoms

Common bean mosaic and its variant strain cause a stunting of the plant and a mottling and malformation of the leaves (fig. 11). The leaves become irregular in shape, with light-green areas interspersed between dark-green puckered areas. Plants of some varieties set few pods and retain their green color until frost, long after noninfected

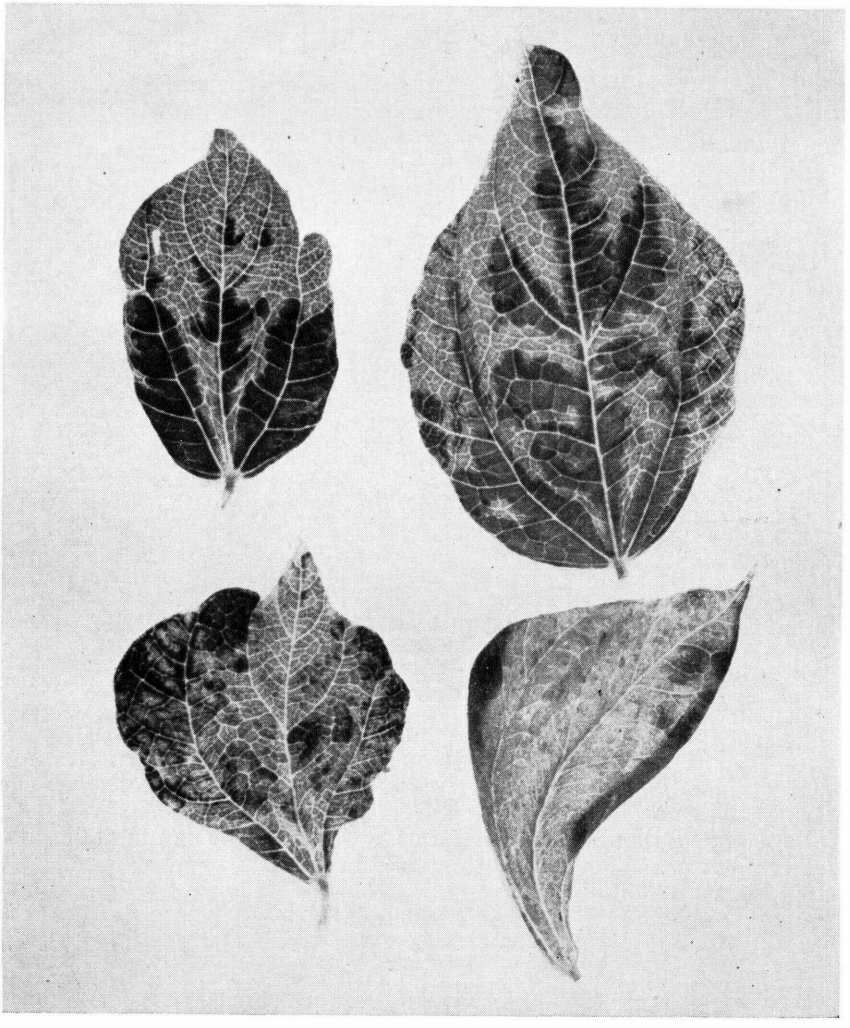

Figure 11.—Bean leaflets infected with the common bean mosaic.

plants have matured. Plants attacked late in the season may produce a normal crop.

The symptoms of yellow bean mosaic are sometimes difficult to distinguish from those caused by common bean mosaic. Ordinarily, with yellow bean mosaic there is more contrast between the yellow and green areas and the plant becomes very bushy and stunted. Pods produced on these plants are apt to be seriously deformed.

Control

Use resistant varieties to control common bean mosaic and its variant; otherwise plant disease-free seed. Plant certified seed of the mosaic-resistant varieties if available. Roguing fields gives only temporary relief from the disease. Monroe, a pea bean, is the only variety grown in the Eastern States at present that is resistant to both strains of common bean mosaic. Michelite and Robust pea beans are resistant to bean virus 1 but not to the variant strain.

To reduce losses from yellow bean mosaic, avoid planting beans next to clover fields and gladiolus. Also, keep fence rows free of sweetclover.

Sclerotinia Wilt

Cause

Sclerotinia wilt, known also as white mold or watery soft rot, is especially important in fields with heavy vine growth and during seasons of high humidity and rainfall. The fungus produces small black bodies, or sclerotia, on and in the stems and pods of infected plants. At harvesttime the sclerotia fall to the ground, where they may lie dormant for 10 to 20 years. When conditions are favorable for fungus growth, strands of white mold grow out of the sclerotia and infect plants directly or they may produce small tiny mushrooms upon which spores are produced. The spores are ejected into the air and carried by air currents to the leaves and stems of bean plants.

The disease can be transmitted through infected seed. It appears that the sclerotia are the principal source of field infection. Present methods of combining tend to spread the disease, as the sclerotia are scattered back over the land during combining.

Symptoms

Sclerotinia wilt appears first as small water-soaked spots on the stems, leaves, and pods. These spots enlarge rapidly under cool, moist conditions, and in a day or two white masses of mold appear on the infected spots (fig. 12). The mold soon turns gray or brown, and the small black bodies known as sclerotia appear within them.

The fungus may girdle the main stem or its branches, causing the plant or parts of the plant to wilt and die. Infected pods become soft and mushy. Later the pods dry out, becoming light and shriveled. If the plant is attacked early, no pods may be set.

Control

Follow as long a crop rotation as possible to control sclerotinia wilt. Use such crops as small grains, corn, and hay in the rotation, as these crops are not susceptible to the disease.

Figure 12.—Advanced stage of sclerotinia infection on beans.

Root Rots

Cause

Root rots are caused by a number of soil-inhabiting fungi, and in some years they may cause extensive damage to the bean crop. These fungi also attack other crops and are able to survive for long periods in soils where no cultivated crop is grown.

Symptoms

Root rot fungi attack the plant below soil level, forming lesions of various sizes on the stem and root system. The lesions vary from gray to brown, black, or even bright red. Weakening of the root system causes the plant to become yellow and stunted, and in severe cases the plant dies. Furthermore, a plant stunted by root rot appears to be more susceptible to other bean diseases.

Fusarium root rot causes a reddish discoloration of the roots and stems. Invariably the taproot is the first to rot off, followed by the secondary roots. New roots are produced above the infected part of the plant. During a dry season, when there is insufficient moisture for new roots to establish themselves, the plant may die. If the new roots become established the plant may recover in part, but it never regains the vigor of a noninfected plant and the result is a reduction in the number of pods set on the plant.

Infections caused by other root rot fungi generally occur during the early stages of plant growth, and this type of root rot is called

damping-off or seed decay. These fungi usually attack beans growing in wet, cold soils. Bean seed may rot in the ground before or during germination or the seedling may become twisted and stunted. Brownish cankers may form on the roots and the stem below the soil line. Occasionally, the stem is girdled, causing the plant to die.

Control

To control losses from fusarium root rot, practice a crop rotation with at least 4 or 5 years between bean plantings.

Treat the seed with a fungicide to control seed decay and damping-off. Use 2 ounces of 75 percent thiram or 2 ounces of 75 percent captan per 100 pounds of seed.

Powdery Mildew

Cause

Spores of the powdery mildew fungus are produced in abundance on the leaves, pods, and stems and are carried from plant to plant by air currents. The disease develops rapidly once it becomes established and may damage the bean crop in a very short time. This organism usually does more damage to late-maturing crops.

Symptoms

Powdery mildew is easily recognized by the masses of white spores and mycelium appearing on the surfaces of the leaves, stems, and pods. Infected leaves become yellow and fall off, whereas the pods and stem become purplish.

Control

To control powdery mildew, dust the infected crop once or twice with finely ground sulfur at the rate of 20 pounds to the acre. Make the first application when the disease is first noted and the second application about 10 to 12 days later.

Rust

Cause

The fungus responsible for bean rust has two important spore stages in its life cycle—the reddish-brown summer spores and the black resting spores. The summer spores are produced in great numbers on both surfaces of bean leaves. These spores are carried long distances by the wind and are responsible for the rapid spread of the disease. The resting spores develop late in the season and are able to carry the fungus through the winter.

Rust generally occurs in late-maturing beanfields, and occasionally it destroys entire fields. It is favored by cool, damp or rainy periods.

Symptoms

Bean rust attacks mainly the leaves and pods. The first symptom on the leaves is the presence of small, white flecks on the underside. Within a few days the small flecks break open into rust-colored lesions called pustules. The pustules form on both the top and bottom of the leaves. Later the leaves turn yellow, then brown, and finally dry up and fall off the plant.

Control

Control rust by crop rotation, destruction of old bean straw, and dusting with sulfur when the first infection is noticed in the field. Dust a second time about 2 weeks later. Use 20 to 25 pounds of sulfur per acre for each dusting.

INSECTS [3]

In certain seasons insect infestations cause considerable damage to the bean crop. No special cultural practices to avoid infestation can be carried out to escape all types of insects; however, crop rotation aids in reducing some insect infestations. Most insects can be controlled by proper and timely application of chemical insecticides. The following general principles for applying insecticides to kill pests should be followed:

1. Spray or dust before heavy damage is done to the foliage, roots, or pods.
2. Apply dust or spray materials uniformly to both surfaces of the leaves. Adjust machinery to give complete coverage. Provide additional spray or dust outlets if necessary.
3. Use dosages of chemicals recommended by manufacturer. If less material is used, control is usually unsatisfactory.
4. Use either sprays or dusts, although sprays usually give better control. Certain bean diseases may be spread by dusting equipment when plants are wet with dew or rain.
5. Read and follow directions printed on the label for handling the insecticide. See also section on Precautions, p. 28.

Mexican Bean Beetle [4]

The Mexican bean beetle feeds on foliage and may attack the pods of the bean. The adults and larvae feed usually on the lower surface of bean leaves, leaving the upper surfaces to dry out and die (fig. 13). Heavy damage gives plants a lacelike appearance in which the leaf veins only remain.

Mature beetles pass the winter on the ground in rubbish near bean-fields. The oval yellowish-orange, black-spotted adults appear soon after the beans emerge in the field. After feeding 1 to 2 weeks the adults lay groups of 40 to 60 orange-yellow eggs on the undersurface of leaves. The eggs hatch in 5 to 14 days, and the young larvae feed from 2 to 5 weeks. When full grown the larvae are about one-third inch long, yellow in color, and have their backs protected by rows of black-tipped spines. Most bean injury occurs during July and August.

The use of one of the following materials (see Precautions, p. 28) will give adequate control of Mexican bean beetle:

Insecticide:	*Rate per acre*
5 percent malathion dust	30 to 40 pounds.
25 percent malathion	3 pounds per 100 gallons of spray.
2 percent parathion dust	30 to 40 pounds.
15 percent wettable powder parathion	3 pounds per 100 gallons of spray.
25 percent parathion emulsion	2 pounds per 100 gallons of spray.

[3] Prepared by Leeland Merrill, assistant professor, Entomology Department, Michigan State College.

[4] Scientific names of insects appear on p. 29.

Figure 13.—Mexican bean beetle larvae feeding upon been leaves.

Apply one of the insecticides listed above when the bean plants are 3 to 5 inches tall to kill the beetles that are present at that time. If the infestation is heavy, apply a second time 1 to 2 weeks later when most of the eggs have hatched.

Other chemicals, such as rotenone, are effective against the Mexican bean beetle. Use the rates recommended by the State agricultural experiment station.

Seed-Corn Maggot

The seed-corn maggot is a serious pest of germinating bean seedlings in the northern areas. It may destroy the seed before the seedling can emerge, attack young plants, or destroy the growing tip, thus producing a baldheaded plant. This insect is more destructive in cold soils in early spring and in soils where large amounts of organic matter are present.

The pupal, or resting stage, of the seed-corn maggot passes the winter in or near the beanfield, and in April and May the adult flies appear. These flies mate and lay eggs on or near germinating bean seedlings (fig. 14). Tiny maggots hatching from the eggs burrow into the soil and attack the bean, causing a poor stand and baldheaded and weakened plants (fig. 15).

Before planting bean seeds, protect them from maggot injury by coating them with a thin slurry that contains an insecticide and a fungicide.

Aldrin, dieldrin, or lindane is a suitable insecticide. Use a finely ground, solvent-free wettable powder of 75-percent strength. The

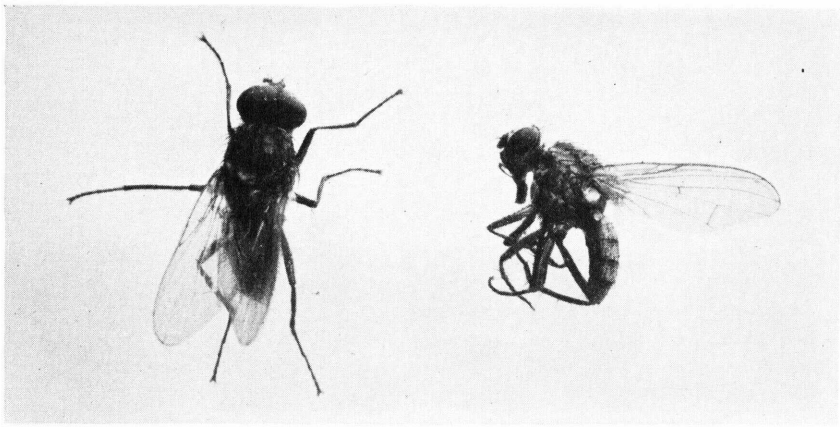

Figure 14.—Adult flies of the seed-corn maggot lay their eggs in or near germinating bean seedlings.

recommended fungicides are thiram and captan. A 75-percent wettable powder is especially prepared for use in slurry.

Prepare the insecticide and the fungicide by mixing with water. To prepare an amount sufficient to treat 100 pounds of seed, mix ⅔ ounce (8 level teaspoonfuls) of the insecticide, 3 ounces (18 level tablespoonfuls) of the fungicide, and 1 pint of water. Stir the mixture thoroughly. Let it stand about 10 minutes before using.

Add the slurry mixture to the beans placed in a drum, and rotate with the beans. If these recommendations are followed, less than an

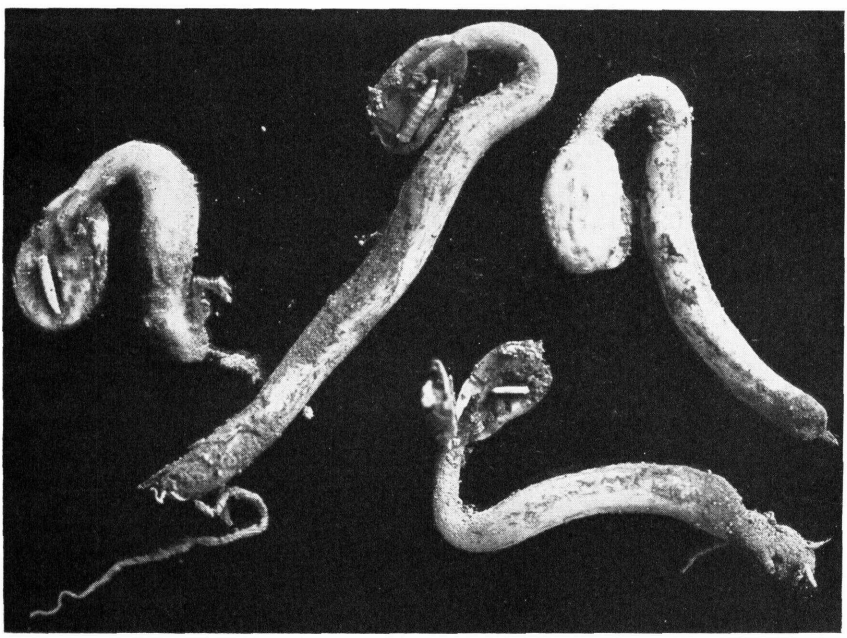

Figure 15.—Bean seedlings attacked by the seed-corn maggot. Note the presence of the maggots on the cotyledons, or seed leaves.

ounce of chemical per acre will reach the soil. This amount of insecticide in the soil does not give off-flavor to bean crops or bean products.

Leafhoppers

Leafhoppers are small wedge-shaped, green insects, about one-eighth inch long. Several types of leafhoppers are found on bean plants, but the most important is the potato leafhopper. The insects feed on the undersides of the leaves, suck out the sap from the veins, and in some manner cause the trouble known as tipburn, or hopper burn. Hopper burn first appears as a brownish spot on the tip of the leaf, and later the browning, or scorching, appears on the margin. The brownish margins increase in width until only a narrow strip of the leaf remains green. The leaves also become stunted and dwarfed.

Large numbers of flying adults may appear as the bean plants emerge from the ground. When a hayfield is cut, the leafhoppers migrate from cut fields into nearby adjacent beanfields.

To control the leafhoppers use several applications of parathion or malathion, as prepared to control the Mexican bean beetle (p. 24), or a 3 or 5 percent DDT dust at 30 or 40 pounds to the acre, or 2 pounds of 50 percent wettable DDT powder per 100 gallons of water.

Bean Weevil

The bean weevil is a small dark-brown to olive-brown beetle about one-eighth inch long (fig. 16). The body narrows evenly toward the small head, and the wing covers do not quite cover the top of the

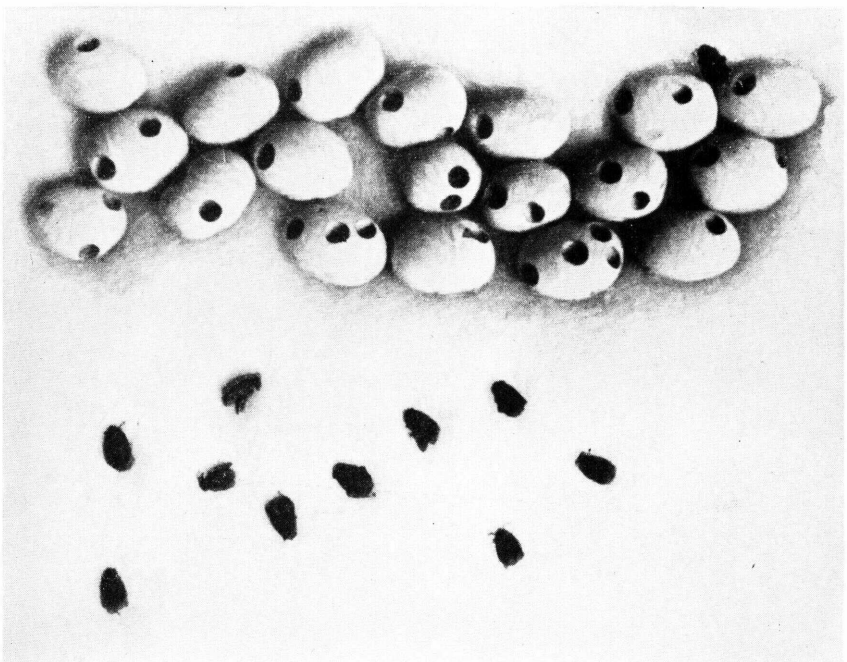

Figure 16.—Beans infested with bean weevil, and small brown weevils that have emerged from the infested seed.

abdomen. The weevils infest either the stored dry bean seeds or the beans growing in the field. In the field the weevil lays its eggs into the pod, where the larvae hatching from the eggs infest the growing bean. In warm storages, the larvae, or grubs, complete their development in the dry bean, form pupae, and finally emerge as adults. The adults can go on breeding in dry beans, providing the temperature and moisture content are high enough to support their activity. Weevil-infested beans contain round emergence holes made by the adults as they force their way out of the bean.

Never plant weevil-infested seed. As soon as the beans are harvested, sack them tightly, and if there is danger in infestation fumigate the beans. Fumigate the beans stored on the farm in a gastight bin or drum. Use a mixture of 1 part carbon tetrachloride and 3 parts ethylene dichloride at the rate of 1 gallon per 100 bushels. A layer of lime spread over the top of the beans will increase the effectiveness of the fumigation treatment.

Plow or burn cracked seeds, vines, and other plant remnants from weevil-infested fields after harvest.

PRECAUTIONS

Chemicals recommended for controlling bean insects and diseases are poisonous to man and animals when taken internally. Some cause a rash if they come into contact with the skin. Anyone using insecticides or fungicides should be very careful to keep them away from his mouth, eyes, and nostrils. Use a respirator or dust mask if a large quantity of seed is to be treated with a chemical in dust form. Put on oiled leather gloves and a rubber or oilcloth apron if a large quantity of chemical in solution is to be applied. Be sure that the unused portion of the solution that is poured on the ground does not stand in puddles. Clean all vessels thoroughly; wash hands and clothing. Store chemicals in closed containers and label them. Put them out of reach of children and farm animals.

Parathion is particularly poisonous and should be applied only by or under the supervision of a trained operator, who will assume full responsibility for its application and enforce the precautions prescribed by the manufacturer. It is extremely toxic if swallowed, inhaled, or absorbed through the skin; it may cause death. Do not attempt to prepare parathion dusts but use them ready-mixed. Do not apply parathion sprays or dusts to the crop within 15 days of harvest.

LIST OF SCIENTIFIC NAMES

Organisms That Cause Diseases of Dry Beans and Insects That Attack Dry Beans

Diseases

Common name	*Causal organism*
Anthracnose	*Colletotrichum lindemuthianum*
Bacterial blights:	
Common blight	*Xanthomonas phaseoli*
Fuscous blight	*X. phaseoli* var. *fuscans*
Halo blight	*Pseudomonas phaseolicola*
Bacterial wilt	*Corynebacterium flaccumfaciens*
Mosaic:	
Common bean mosaic	Phaseolus virus 1 and variant
Yellow bean mosaic	Phaseolus virus 2
Powdery mildew	*Erysiphe polygoni*
Root rots:	
Fusarium root rot	*Fusarium solani* f. *phaseoli*
Damping-off and seed decay	*Pythium aphanidermatum* *P. debaryanum* *Rhizoctonia solani*
Rust	*Uromyces phaseoli* var. *typica*
Sclerotinia wilt	*Sclerotinia sclerotiorum*

Insects

Common name	*Scientific name*
Bean weevil	*Acanthoscelides obtectus*
Mexican bean beetle	*Epilachna varivestis*
Potato leafhopper	*Empoasca fabae*
Seed-corn maggot	*Hylemya cilicrura*

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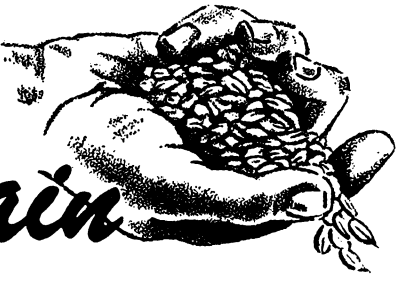

Clean Grain

Makes wholesome flour and cereal products

Cleanliness in grain begins on the farm

Insects, birds, and rats and other rodents that get into stored grain cause enormous losses. They waste the nation's food and eat away your profits. You can help cut these losses by making sure that all the grain you store and handle is clean.

Keep rats and mice out with better storage construction. Poison and trap rodents and clean up places where they may hide and live.

Keep insects out. Fumigate old stored grain. Before storing new grain, get rid of insects by cleaning the bins and areas surrounding them. Spray bins with insecticide.

Use screens to keep out birds and poultry. Use ½-inch mesh hardware cloth or similar material over all windows and other openings.

GRAIN IS FOOD • • • KEEP IT CLEAN